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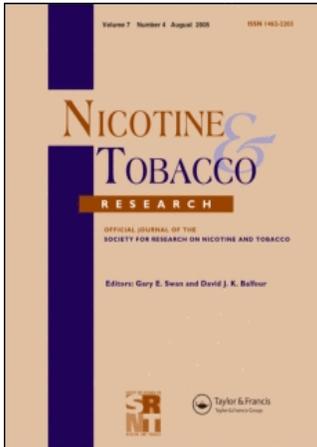
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Declining mortality from smoking in the United States

Brad Rodu, Philip Cole

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The proportion of Americans who smoke cigarettes has declined 50% since 1965. The effect on mortality of this considerable reduction has received little attention and is described in this study. U.S. national data were used to enumerate current, former, and never-smokers aged 35 years or older in 1987 and 2002. Mortality rate ratios were used to estimate smoking-attributable deaths among these groups, and corresponding age-adjusted smoking-attributable mortality rates (SAMRs) were calculated. There were 402,000 deaths attributable to smoking in 1987 and 322,000 in 2002. The SAMR for men aged 35 years or more was 556 deaths per 100,000 person-years in 1987, accounting for 24% of all male deaths. By 2002 the SAMR declined 41% to 329 and accounted for only 17% of deaths. The SAMR for women in 1987 was 175, accounting for 12% of deaths. By 2002 the SAMR among women had declined 30% to 122, representing 9% of deaths. The U.S. mortality rate attributable to smoking declined about 35% between 1987 and 2002. The impact of smoking on American society will diminish even further in the foreseeable future as smoking prevalence continues its decline among men and women.

Introduction

In many respects the United States and the United Kingdom are quintessential examples of the slow but substantial decline in cigarette smoking rates in the developed world. Smoking prevalence in both countries has declined since at least the mid-1960s, following landmark reports from the British Royal College of Physicians and the U.S. surgeon general. In the United Kingdom the prevalence of smoking among men was about 55% in the late 1960s, declining to 26% by 2004; smoking rates among women dropped from 50% to 23% (Peto et al., 2000). A similar pattern was seen in the United States, where smoking prevalence among men decreased from 52% in 1965 (Giovino et al., 1994) to 23% in 2004 (Centers for Disease Control and Prevention [CDC], 2005b), and rates among women declined from 34% to 19%.

The lethal effects of smoking are well known. In contrast, little is known about the effect of the decline in smoking prevalence on overall mortality, even though evidence indicates major effects on individual diseases. For example, reductions in smoking may be responsible for as much as one-half of the decrease in heart disease mortality in the United Kingdom and the United States (Unal, Critchley, & Capewell, 2004). Reductions also played a key role in the unprecedented decline in American cancer mortality beginning in 1991 (Cole & Rodu, 1996). However, the full impact of these declines is not appreciated, because government reports emphasize disease-specific numbers of deaths, which have changed little over the past 15 years (CDC, 1993, 2004).

The present study assessed the impact of the decline in smoking prevalence both on numbers of deaths and on overall mortality rates in the United States.

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Method

Data files from the National Health Interview Survey (NHIS) were downloaded from the Inter-University Consortium for Political and Social Research

(ICPSR) for analysis with SPSS version 14.0 for Windows statistical software (U.S. Department of Health and Human Services [USDHHS], 1990, 2005). Information on deaths was obtained from the Compressed Mortality File of the National Center for Health Statistics (NCHS; USDHHS, 2006). The starting year was 1987 because it approximates the peak in the number of deaths attributable to smoking (NDAS), according to the CDC (1993). We ended with 2002 because it was the most recent year for which complete NCHS statistics were available. The 2002 NHIS file was unavailable to us due to a technical problem at ICPSR, so 2003 NHIS prevalence data was used. All estimates were adjusted to the size and age structure of the NCHS population.

Categories of smokers and number of deaths attributable to smoking

Using NHIS surveys, we determined the numbers of current, former, and never-smokers by gender and age (10-year groups from 35–44 to 85+ years) in 1987 and 2002. Former smokers were further divided into three groups based on the number of years since quitting (YSQ): 0–4, 5–14, or 15+ years.

Data provided to us by the American Cancer Society (personal communication from Jane Henley) from its second Cancer Prevention Study (CPS-II; USDHHS, 1997) were used to derive gender- and age-specific mortality rate ratios for all causes of death combined for current and for former smokers relative to never smokers. The mortality rate ratios were applied to the total number of deaths reported by NCHS in 1987 and 2002 to derive gender- and age-specific all-cause mortality rates among current, former, and never-smokers.

NDAS among current smokers was estimated by subtracting the number of deaths that would have occurred in that group at never-smokers' mortality rates from the number of deaths occurring at smokers' rates. Estimates of NDAS among former smokers were derived in a similar manner and with respect to YSQ status. Former smokers with 0–4 YSQ were treated as if they were current smokers, and former smokers with 5–14 YSQ were assigned the mortality rate ratios of former smokers. Former smokers with 15+ YSQ were treated as never-smokers and therefore did not contribute NDAS in this analysis. This approach was based on risk estimates from other studies (Doll, Peto, Boreham, & Sutherland, 2004; Jacobs et al., 1999).

Smoking-attributable mortality rates

Gender- and age-specific smoking-attributable mortality rates (SAMRs) were obtained by dividing each

NDAS by the size of the corresponding NCHS population. The rates were adjusted by the direct method to the U.S. 2000 standard population, and expressed as deaths per 100,000 person-years.

For comparability over time, all estimates of NDAS and of SAMRs, including those from the CDC, related only to current smokers and former smokers of cigarettes. Deaths related to perinatal conditions, burns, environmental tobacco smoke, and other forms of tobacco were excluded.

Results

Current, former, and never-smokers

Table 1 shows the number of current, former, and never-smokers in the United States in 1987 and 2002. The number of current smokers for both genders combined was virtually unchanged (29.3 million in 1987, 29.6 million in 2002). However, the age distribution was different. In 1987, 36% of current smokers were older (55+ years), but this group declined to 28% of the total by 2002. In short, there were almost 2.1 million fewer smokers aged 55+ in 2002 than in 1987.

The number of former smokers increased moderately from 31.8 million in 1987 to 39.9 million in 2002. However, their duration of cessation and their age distribution changed considerably. The number of former smokers with 0–4 YSQ declined, from 8.1 million in 1987 to 6.7 million in 2002. The proportion of this group who were older declined from 43% to 41%, a decrease of 770,000 persons. There was little change in the number of former smokers with 5–14 YSQ, from 9.9 million in 1987 to 10.1 million in 2002, and the proportion of this group who were older increased slightly, from 45% to 48%. However,

Table 1. Current, former, and never-smokers (in millions), aged 35+ years in the United States, 1987 and 2002.

Smoking status	Men	Women	Both
1987			
Current smokers	15.1	14.2	29.3
Former smokers	20.1	11.7	31.8
YSQ			
0–4	4.6	3.5	8.1
5–14	5.9	4.0	9.9
15+	9.6	4.2	13.8
Never smokers	15.0	32.6	47.6
All	50.2	58.5	108.7
2002			
Current smokers	15.5	14.1	29.6
Former smokers	22.5	17.4	39.9
YSQ			
0–4	3.6	3.1	6.7
5–14	5.4	4.7	10.1
15+	13.5	9.6	23.1
Never smokers	31.6	46.1	77.7
All	69.6	77.6	147.2

Note. YSQ, years since quitting.

major changes occurred among former smokers with 15+ YSQ. Their numbers increased from 13.8 million in 1987 to 23.1 million in 2002. The proportion of this group who were older increased marginally from 65% in 1987 to 68% in 2002.

There were 47.6 million never-smokers in 1987 and 77.7 million in 2002, a 63% increase.

Number of deaths attributable to smoking

There were 402,000 deaths attributable to smoking in 1987, of which 266,000 occurred among current smokers, 90,300 among former smokers with 0–4 YSQ and 45,600 with 5–14 YSQ. By 2002 NDAS had declined by 20% to 322,000, including 212,200 deaths among current smokers, 67,900 among former smokers with 0–4 YSQ and 42,000 with 5–14 YSQ. The rate of decline in NDAS was similar for all categories of male smokers and for female current smokers. However, among female former smokers NDAS declined only 4% among those with 0–4 YSQ and increased by 20% among those with 5–14 YSQ.

Smoking-attributable mortality rates

For men, the SAMR was 556 deaths per 100,000 person-years in 1987 (Table 2), accounting for 24% of all deaths among men aged 35 years or more. By 2002, the SAMR had declined 41% to 329, and smoking accounted for only 17% of deaths among men. In 1987 the SAMR for women was 175, accounting for 12% of all deaths. By 2002, it had declined 30% to 122 and accounted for 9% of deaths among women.

Discussion

The impact of smoking as a cause of death in American society is waning, as the mortality rate attributable to smoking in the United States declined about 35% between 1987 and 2002. The decline results from reductions in the numbers of current and recent former smokers, especially at older ages when smoking imposes high excess mortality. The use of

SAMRs has a distinct advantage when compared with a count of deaths because it places the declining mortality from smoking in the context of the overall decline in mortality that occurred among all Americans during this period. In fact, the rate of SAMR decline (35%) exceeded that from other causes in both men and women; smoking accounted for an appreciably smaller proportion of American deaths in 2002 than it did in 1987.

The present study used the same data sources that the CDC uses for its estimates: NHIS for classifying and enumerating current and former smokers, CPS-II for mortality rates and mortality rate ratios, and NCHS for population estimates and numbers of deaths. However, our NDAS estimate is derived for a single, “all-causes” category of deaths, whereas the CDC designates as many as 19 individual disease-specific causes of death that it considers to be related to smoking (CDC, 2004). The agency then estimates relative risks among current and former smokers for each of these diseases. Over time, the CDC has increased the relative risks it uses for some diseases (CDC, 2002), making it difficult to assess time trends for NDAS. In addition, the CDC’s list of smoking-attributable diseases changes. For example, in its most recent report the CDC added stomach cancer and acute myeloid leukemia but removed hypertension (CDC, 2005a). The CDC’s disease-specific approach is useful for educational or public health campaigns (Malarcher et al., 2000), such as those of the American Cancer Society and the American Lung Association. But the CDC’s multi-disease approach lends itself to imprecision—estimating 19 excess rates is less precise than estimating 1. Most important, this approach does not describe the overall impact of smoking in a way that is consistent over time.

Because former smokers make up over 50% of the population at risk, their enumeration is important for developing NDAS estimates. In fact, the large numbers of former smokers used in the present study and in CDC estimates reflect the very inclusive NHIS definition (smoked 100 cigarettes, or five packs, in their lifetime; CDC, 2005b; Giovino et al., 1994). This definition includes even transitory or experimental smokers who quit decades ago. In contrast, CPS-II defines former smokers in a more limited and realistic way (smoked at least once daily for 1 year or more; Thun, Apicella, & Henley, 2000). Thus applying CPS-II-derived mortality rate ratios to NHIS-defined former smokers would result in inflated NDAS estimates. Our approach stratifies former smokers by YSQ and so reconciles the discrepant definitions of CPS-II and NHIS. It is unclear whether or how the CDC manages the discrepancy between NHIS and CPS-II definitions, since “data are not available for former or current

Table 2. Mortality rates for men and women aged 35+ years in the United States, 1987 and 2002, according to cause.^a

Cause	1987	2002	1987–2002 Decline	
			Rate	%
Men				
Smoking	556	329	227	41
Other	1,746	1,555	191	11
All	2,302	1,884	418	18
Women				
Smoking	175	122	53	30
Other	1,271	1,224	47	4
All	1,446	1,346	100	7

Note. ^aDeaths per 100,000 person-years, adjusted to the U.S. 2000 Standard Population.

smokers separately” (personal communication from the CDC, March 2, 2006).

The mortality estimates from the present study, as well as those from the CDC, are based on the smoking patterns of the CPS-II subjects enrolled in 1982. Alterations in smoking patterns, such as age at initiation and per-capita cigarette consumption, are likely to change the mortality experience of American smokers in the future.

Smoking remains an important cause of avoidable deaths in the United States, but the present study shows that smoking is losing its impact on all-cause mortality. This trend will continue for the foreseeable future as smoking prevalence continues to fall.

Acknowledgments and declarations

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